Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8934596820

PHYSICAL SCIENCE **0652/41**

Paper 4 (Extended) **October/November 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

A copy of the Periodic Table is printed on page 20.
Electronic calculators may be used.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **19** printed pages and **1** blank page.

Cambridge Assessment International Education

1 An athlete of mass 75.0 kg runs a 100 m race in a time of 10.5 s.

The 100 m race is run on a straight track.

(a) Calculate the average velocity of the athlete.

Show your working.

average velocity = ... m/s [2]

(b) The graph in Fig. 1.1 shows the variation of speed of the athlete during the race.

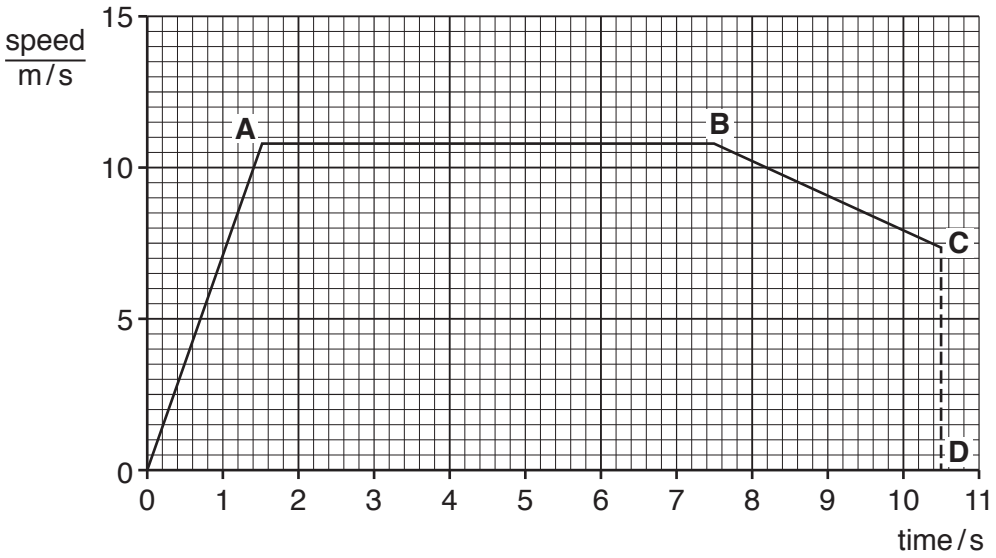


Fig. 1.1

Calculate the deceleration of the athlete in the section **BC**.
Show your working and give the unit.

deceleration = ... unit ..... [3]

(c) The 100 m race is run on a straight track. A 400 m race is one lap of a circular track.

Explain why it is **not** correct to use the term *average velocity* when describing the 400 m race.

.....

.....

.....

..... [2]

[Total: 7]

2 A student investigates the reaction between ammonia gas, NH_3, and hydrogen chloride gas, HCl.

She sets up the apparatus shown in Fig. 2.1.

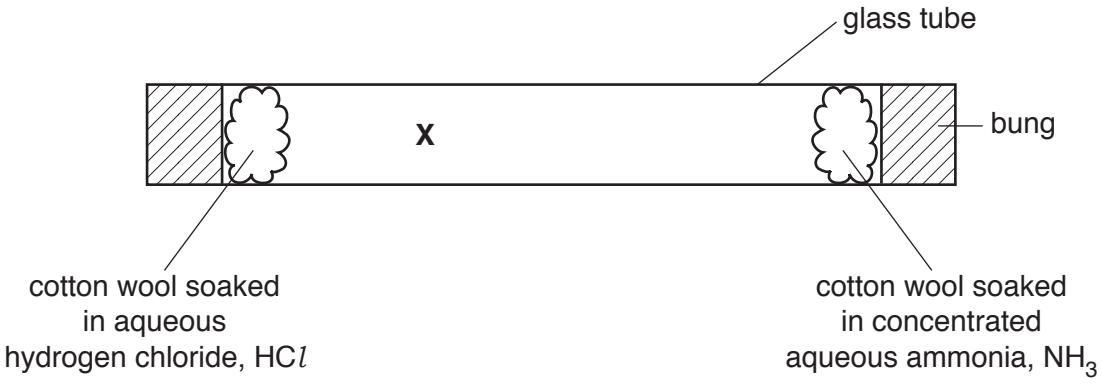


Fig. 2.1

Particles of NH_3 and particles of HCl spread through the glass tube. They meet at position **X** and react to form ammonium chloride, NH_4Cl.

(a) Name the process by which the particles of a gas spread out.

..... [1]

(b) **(i)** Calculate the relative molecular mass of NH_3 and of HCl.

[A_r: H, 1; N, 14; Cl, 35.5]

NH_3 .....

HCl .....

[1]

(ii) Write a balanced symbol equation for the reaction between ammonia gas and hydrogen chloride gas. Include state symbols.

..... [2]

(c) Explain why ammonium chloride forms closer to the HCl end of the glass tube than to the NH_3 end.

.....

..... [1]

[Total: 5]

3 Fig. 3.1 shows part of a domestic water heating system.

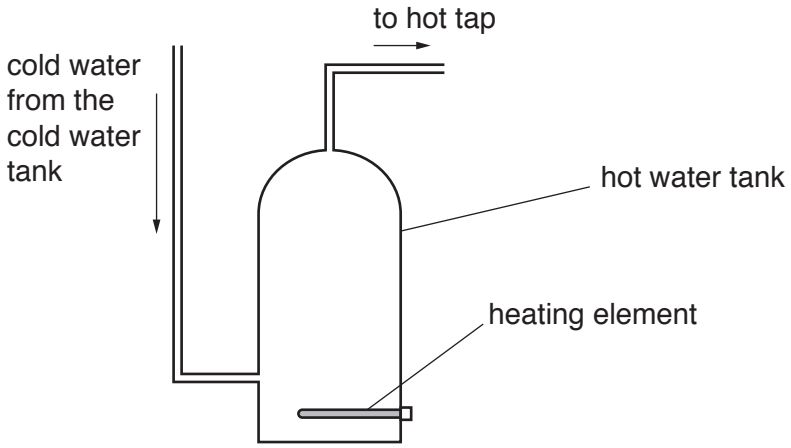


Fig. 3.1

(a) (i) Explain why the heating element is at the bottom of the hot water tank.

.....

.....

.....

.....

.....

..... [3]

(ii) A lot of thermal energy is lost from the hot water tank.

Suggest how this energy loss can be reduced.

.....

..... [1]

(b) The hot water tank is made from copper.

Copper is a good conductor of thermal energy.

Explain, by referring to electrons, why copper is a good thermal conductor.

.....

.....

.....

..... [2]

[Total: 6]

4 A chemist assesses the purity of three solid compounds, **A**, **B** and **C**, using their melting points.

Table 4.1 shows the results.

Table 4.1

	compound		
	A	**B**	**C**
melting point / °C	131–139	35	35

(a) Explain why the data suggests that compound **A** is **not** pure.

.....

..... [1]

(b) The chemist adds compound **B** to compound **C**. The mixture melts between 28–32 °C.

The chemist has not made a mistake.

Explain why the melting point of the mixture is **not** 35 °C.

.....

.....

.....

..... [2]

(c) Explain why chromatography is **not** a suitable method to use to assess the purity of the three solid compounds.

.....

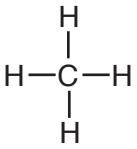
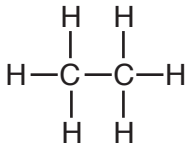
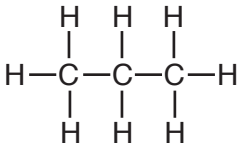
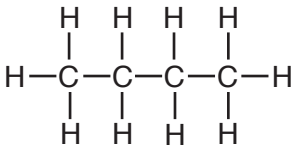
..... [1]

[Total: 4]

[Turn over

5 Table 5.1 shows information about some organic compounds.

Table 5.1

compound	molecular formula	structure
methane	CH_4	
ethane	C_2H_6	
propane	C_3H_8	
butane	C_4H_{10}	

The compounds are members of a homologous series.

(a) (i) State what is meant by the term *homologous series*.

.....

.....

.....

..... [2]

(ii) Name the homologous series to which the compounds in Table 5.1 belong.

..... [1]

(iii) Explain how the information in Table 5.1 shows these compounds are saturated.

.....

..... [1]

(b) Organic compounds can be cracked into smaller molecules.

(i) State **two** conditions needed for cracking.

1. .....

2. .....

[2]

(ii) Complete the equation to show the products of cracking C_2H_6.

$$C_2H_6 \rightarrow C_2H_4 + \text{.....}$$ [1]

[Total: 7]

[Turn over

6 Fig. 6.1 shows a circuit diagram.

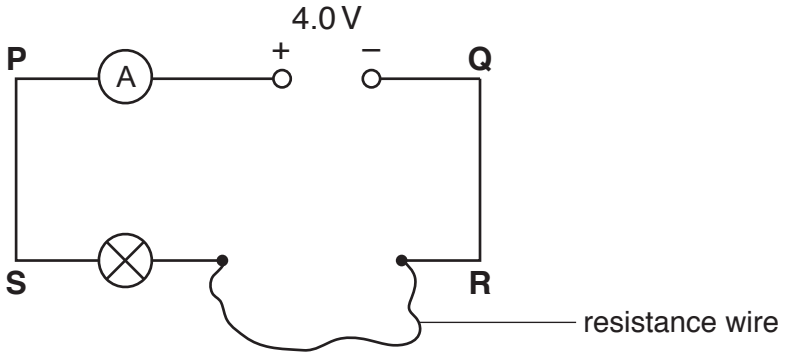


Fig. 6.1

The power supply has a fixed e.m.f. of 4.0 V.

(a) 1. Draw an arrow between **P** and **S** to show the direction of the conventional current in the circuit.

2. Draw an arrow between **Q** and **R** to show the direction of the movement of electrons in the circuit.

[1]

(b) On Fig. 6.1, draw a voltmeter to measure the potential difference across the lamp. [2]

(c) The resistance wire is chosen so that the potential difference across the lamp is 1.5 V. The lamp has a power of 2.5 W.

(i) Calculate the current in the lamp.

current = ... A [2]

(ii) Calculate the potential difference across the resistance wire.

potential difference = ... V [1]

(iii) Calculate the resistance of the resistance wire.

resistance = ... Ω [2]

(d) A different resistance wire **X** has a diameter of 0.40 mm. The resistance of wire **X** is 4.5 Ω.

Another wire **Y** of the same length and made from the same material as wire **X** has a diameter of 0.20 mm.

Calculate the resistance of wire **Y**.

resistance = ... Ω [2]

[Total: 10]

7 The equation for the extraction of zinc, Zn, from its ore, ZnS, takes place in two stages.

(a) **Stage one** of the extraction of Zn uses oxygen.

The equation for stage one is shown.

$$2\,ZnS(s) + 3\,O_2(g) \rightarrow 2\,ZnO(s) + 2\,SO_2(g)$$

Calculate the mass of ZnO that is produced from 7.0 tonnes of ZnS.

1 tonne = 1000 kg

[A_r: Zn, 65; S, 32; O, 16]

Show your working in the box.

mass of ZnO = ... tonnes

[3]

(b) **Stage two** of the extraction of Zn uses carbon.

The equation for stage two is shown.

$$ZnO(s) + C(s) \rightarrow Zn(l) + CO(g)$$

(i) Name the substance that acts as a reducing agent in this reaction.

..... [1]

(ii) Carbon monoxide gas, CO, is a pollutant.

State **one** adverse effect of carbon monoxide gas.

.....

..... [1]

(iii) Carbon monoxide gas is released in the exhaust gases of car engines during the combustion of fossil fuels.

Describe how carbon monoxide can be removed from the exhaust gases of car engines.

.....

.....

.....

..... [2]

(c) Zinc is used for galvanising steel. This helps prevent the corrosion of steel.

Explain why galvanising steel with zinc helps to prevent the corrosion of steel.

.....

.....

.....

.....

.....

..... [3]

(d) Mild steel is an alloy of iron.

State **one** benefit of mixing additives with iron to produce an alloy.

.....

..... [1]

[Total: 11]

8 Fig. 8.1 shows a ray of light incident on a glass block.

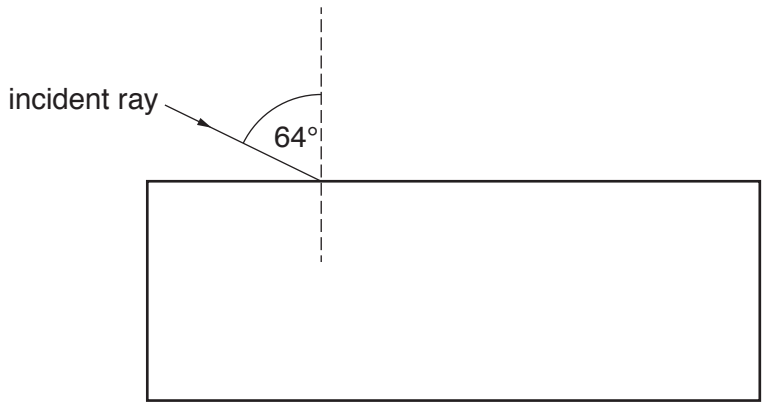


Fig. 8.1

The angle of incidence is 64°.

(a) On Fig. 8.1, draw the path of the ray of light as it passes through and leaves the block. [2]

(b) The glass block has a refractive index $n = 1.48$.

Calculate the value of the angle of refraction.

Show your working.

angle of refraction = ... ° [3]

(c) The speed of light in air is 3.0×10^8 m/s.

Calculate the speed of light in the glass block.

speed of light in the glass block = ... m/s [2]

[Total: 7]

9 Fig. 9.1 shows a simple d.c. motor.

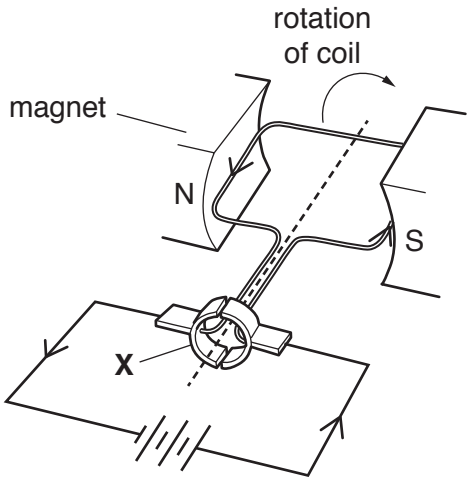


Fig. 9.1

(a) Explain why the coil of the motor turns when there is a current in it.

.....

.....

.....

..... [3]

(b) **(i)** Name the part labelled **X**.

..... [1]

(ii) Describe the role of part **X** in the operation of the motor.

.....

.....

..... [2]

[Total: 6]

[Turn over

10 (a) A student investigates the electrolysis of molten magnesium chloride, $MgCl_2$.

Fig. 10.1 shows the apparatus used by the student.

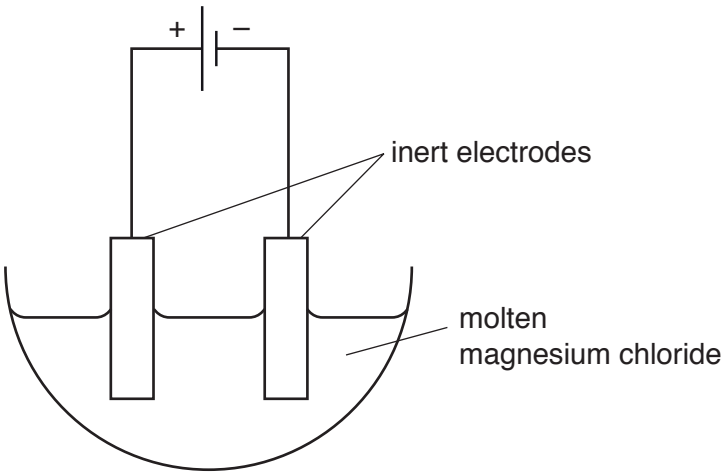


Fig. 10.1

(i) Explain why the magnesium chloride must be molten for electrolysis to occur.

.....

..... [1]

(ii) Predict the products formed at each electrode during the electrolysis of molten magnesium chloride, $MgCl_2$.

positive anode .....

negative cathode .....
[2]

(iii) Magnesium chloride, $MgCl_2$, is an ionic compound.

Draw the dot-and-cross diagram to represent the ionic bonding in magnesium chloride.

You only need to show the outer electrons.

[3]

(b) Magnesium is in Group II of the Periodic Table.

Fig. 10.2 shows the elements in Group II of the Periodic Table.

4 Be beryllium 9
12 Mg magnesium 24
20 Ca calcium 40
38 Sr strontium 88
56 Ba barium 137

Fig. 10.2

The reaction between magnesium and hydrochloric acid produces:

- bubbles of hydrogen gas
- a colourless solution of magnesium chloride.

The word equation for this reaction is shown.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The vigorous reaction between barium and hydrochloric acid produces:

- many bubbles of hydrogen gas
- a colourless solution of barium chloride.

The word equation for this reaction is shown.

barium + hydrochloric acid → barium chloride + hydrogen

(i) Predict the products of the reaction of beryllium, Be, with hydrochloric acid.

..... [1]

(ii) Predict whether beryllium is more or less reactive than magnesium. Give a reason for your answer.

.....

..... [1]

[Total: 8]

11 A detector records the activity of a radioactive isotope, Nd-149.

The number of counts detected in one minute is recorded every 0.5 hours.

The results are shown in Table 11.1.

Table 11.1

time / hours	reading on the detector / counts / minute
0	62
0.5	54
1.0	47
1.5	40
2.0	36
2.5	31
3.0	27

The average background radiation in the laboratory is 9 counts / minute.

(a) Explain what is meant by *background radiation*.

.....

..... [1]

(b) Calculate the half-life of Nd-149.

Show your working.

half-life = ... hours [3]

[Total: 4]

[Turn over

12 The reaction between hydrochloric acid and sodium hydroxide solution produces sodium chloride and water. This reaction is exothermic.

The word equation for this exothermic reaction is shown.

hydrochloric acid + sodium hydroxide → sodium chloride + water

(a) State the pH value for the solution formed during this reaction.

..... [1]

(b) State what is meant by the term *acid*, in terms of proton transfer.

.....

..... [1]

(c) On Fig. 12.1:

- draw the energy level diagram for this exothermic reaction
- label the reactants and label the products
- use an arrow to show the energy change.

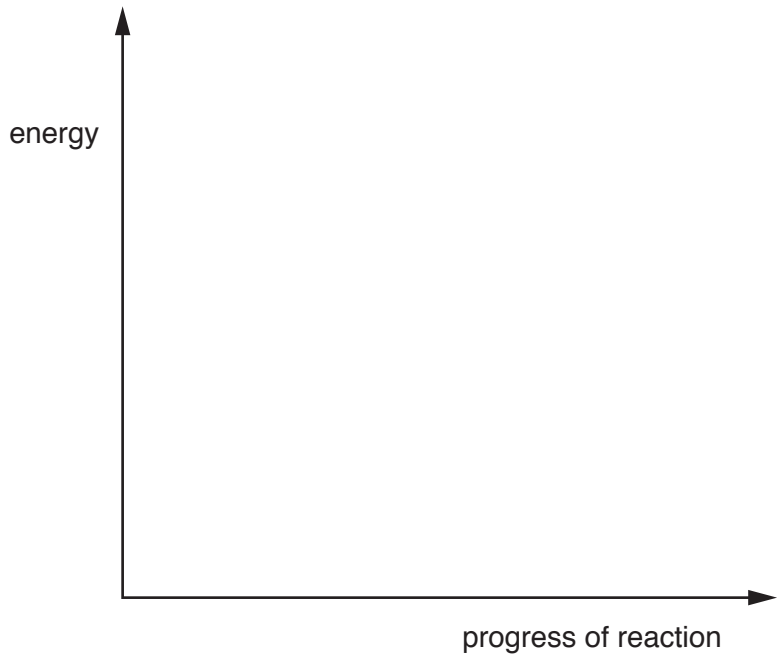


Fig. 12.1

[3]

[Total: 5]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).